RECENT DEVELOPMENTS IN DRAWING BY THE AID OF PROJECTION APPARATUS, USED ON THE HOUSE LIGHTING SYSTEM.

By Simon H. Gage

In the very first accounts that have come down to us of images in darkened rooms (1558-1568), it is insisted on with great enthusiasm that here is a means to aid in drawing the complex images of natural scenery. For example, Daniello Barbero, who first specifically mentions the use of a lens to give a more perfect screen image, says in his work on perspective, Venice, 1568: "Seeing therefore, on the paper screen the outline of things, you can draw with a pencil all the perspective and shading and coloring according to nature, holding the paper tightly till you have finished the drawing."

Following down the stream of history it is found that every great expounder of projection apparatus brings out with emphasis the help which it promises for lessening the drudgery of getting accurate drawings.

The one thing necessary for bringing about the universal employment of projection apparatus for drawing was the general distribution of a source of light of proper intensity to give images of sufficient brilliancy so that the details could be seen clearly enough to be traced with accuracy. The light must furthermore be under control at all hours of the day and night, and furnish the light from a very small source. The electric light fulfills all the requirements, when used from an arc lamp.

The real advance for drawing was made when it was seen that an arc lamp could be made small enough, or rather that the carbons used in an arc lamp could be made small enough, so that the current used in the ordinary house lighting system could be employed to run the arc lamp.

For this most useful addition to the working machinery of the investigator and the student, we are most indebted to Dr. L. Edinger,

the eminent director of the Neurologic Institute at Frankfort on the Main. In 1907, only five years ago, he replaced his drawing and photographing outfit using oil or gas light, by one using a small arc lamp. This small arc lamp was worked out and perfected by the optical works of Leitz at Wetzlar.

This method of drawing has been so far perfected and cheapened that it is now available for private workers as well as for institutions; for students as well as for directors of laboratories.

It seemed to the writer that perhaps he could do no better service at this time than to call attention to the method, and point out from his experience with all the forms some of the necessary rules to follow to get the best results most easily and safely.

In the first place one must possess an arc lamp in which the carbons are held at right angles to each other; and, in passing, it is gratifying to remember that the now so widely used right angled arc lamp for projection, was devised in 1894 by Mr. Albert T. Thompson of Boston. Without a lamp for holding the carbons in this position so that the one giving the light can remain constantly in the optic axis, the small drawing outfits would be practically impossible.

The carbons must be small, from the small current used, viz.: 3 to 6 amperes; and they should be soft cored. A small arc lamp is a convenience, but any arc lamp designed for the carbons at right angles can be used by employing bushings or adapters to hold the small carbons.

Either direct or alternating electric current can be used. One must know which current is on his house lighting system, and also the voltage. Both these facts can be learned by inquiry at the office of the electric lighting company furnishing the electricity.

Installing an Alternating Current Arc Lamp.

As alternating current systems are more common than direct current ones, an outfit on such a system will be first considered.

In the first place, it cannot be stated with too much emphasis that: *"One must never try to use an arc lamp on the house lighting system without a rheostat.* Hence in purchasing the outfit it is necessary to get a rheostat adapted for the voltage (usually 110 or 220) and which will not allow more than 5 to 6 amperes of current to flow

through the lamp. If more current were allowed to flow the fuses of the line would be burned out.

Assuming that the worker has the proper rheostat and lamp, how shall it be connected with the lighting system?

Wiring for the small arc lamp:—This is shown in fig. 1, which is especially prepared to show how to install this drawing outfit. It is also shown in fig. 6, 13, and 14. One can use the good, heavy flexible twisted wire, but it is better to use the asbestos covered cable employed for flat irons and other heating devices. A cord from one to three meters in length (3 to 10 ft.) will usually suffice.

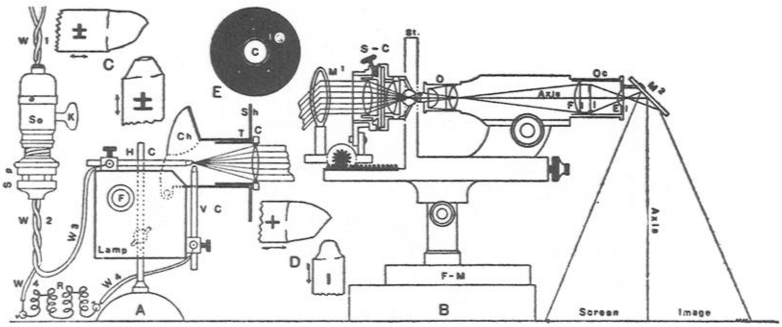

Fig 1

Fig. 1. Diagram of the Microscope for drawing, the Arc Lamp with small right angled carbons, the Wiring, the Rheostat and the connections with the house lighting system.

A. The small arc lamp with the condenser (C) giving parallel rays, the vertical (V-C) and the horizontal (H-C) carbons; F the feeding mechanism, and the wires (W3, direct from the line, W4 through the rheostat). The rheostat (R) is in one wire. The separable plug (Sp) is connected below with the cable (W2) and above with the lamp socket (So) with its key switch, (K). Still above is the incandescent lamp cable (W1) connecting the lamp socket with the house current.

B. The Microscope in section showing the beam of parallel rays from the lamp condenser entering the substage condenser (S-C) directly (as in fig. 14) or reflected in by the mirror (M^1) as in fig. 2, 3, 12, 15); St. Stage of the microscope; O objective, Fl, I, El, the field lens, the real image and the eye lens of the ocular (Oc); M^2 the prism or 45 degree mirror for reflecting the image forming rays down on the drawing paper.

C. Cored carbons of equal size for alternating current.

D. Carbons of the correct relative size for direct current.

E. Face view of the disc on the end of the lamp condenser tube showing the condenser (C) and the spot of light (I) reflected back from the substage condenser.

(1) One end of the cord is connected with the cap of a separable attachment plug (figs. 1, 6). This connection must be carefully and thoroughly made so that there will be no short circuits.

(2) One of the wires of the cable is cut some distance from the other end, and one of the cut ends is attached to one binding post, and the other to the other binding post of the rheostat (figs. 1, 2, 3). This will put the rheostat in series, as it is called. No current can then flow through the lamp or indeed along the wires without passing through the rheostat.

(3) The wires at the end of the cable are now connected with the binding posts of the arc lamp—one wire for each carbon.

All binding screws for connecting the wires with the separable plug, the rheostat, or the arc lamp should be set tight so that there will be good metallic connection and so that, in using the apparatus, the wires will not separate from their connections.

Connection with any lamp socket of the house lighting system can now be made by means of the separable attachment plug (figs. 1, 6).

The arc lamp must be supplied with soft cored carbons not over 8 mm (5-16 in.) in diameter. If only from three to four amperes of current is used, then the carbons should not be over 6 mm. (1-4 in.) in diameter. One must select carbons of a size that the whole end will be heated by the current used or the light will not remain constantly in one axis, and it will be necessary to change the mirror of the lamp to get the light in the optic axis every time the crater wanders on the carbon tip. If the whole end of the carbon is white hot, as will occur if the carbon is small enough, then the light will be steady.

The ends of the two carbons must be in the correct relative position as shown in fig. 1 or the best light will not be given, due to the shading of one carbon by the other.

Installing a Direct Current Arc Lamp

As a direct current arc lamp gives more than twice as much light for the same amperage as the alternating current, it would always be used if available.

The same lamp serves for both currents. The only difference is that for the direct current the upper carbon must be larger as the positive carbon burns out faster than the negative carbon. This is a good proportion: Upper or positive carbon 8 mm. in

diameter; Lower or negative carbon 6 mm. in diameter. Then they will shorten about equally.

With the alternating current each carbon is positive half the time; with the direct current one carbon is positive all the time and one negative all the time.

In installing the lamp one proceeds precisely as for the alternating current, that is, a separable plug is connected with one end of the cable; a rheostat is inserted along one of the wires, and the other end of the cable has one wire to each binding post of the arc lamp (fig. 1). The only complication is that the positive wire must be connected with the binding post of the upper carbon, and the negative wire to the binding post of the lower carbon.

Usually one does not know which wire is positive and which is negative, and it is necessary to find out by experiment as follows: Connect up the lamp as for the alternating current without regard to positive and negative. Put in some equal sized carbons and turn on the current. Let it run for a minute or two and then separate the carbons till the lamp goes out, then look at the carbons and watch them while they cool. The positive one will be brightest in the beginning, and stay red the longer. If the upper one is brightest it shows that the lamp is connected up correctly. If the lower one is brightest the polarity is turned around. To correct this, pull out the cap of the separable plug, turn it half way around and insert it again. This should reverse the polarity and cause the current to run through the lamp in the right direction. Light the lamp again and make sure that the upper carbon is the brightest and remains glowing the longest. Finally when the upper carbon is positive some kind of a mark should be made on the lamp socket, the plug and its cap so that all can be connected in exactly the same way again, or one would have the trouble of correcting for polarity every time the connections were made.

For turning on the lamp and putting it out, proceed exactly as for the alternating current lamp.

Carbons for the Direct Current Lamp.—Use 8 mm. carbons for the upper or positive one and 6 mm. carbons for the negative or lower one; 7 upper, 5 lower answer also.

One must look at the carbons occasionally and be sure that they are in the correct relative position to give unobstructed passage to the light toward the condenser (fig. 1 C).

Feeding the Carbons Together.—One must feed the carbons together every two or three minutes for the best effect. With the alternating current the arc might burn for 10 minutes, but the light is not so good as when the carbons are fed often.

Condenser for the Small Arc Lamp.—To collect the light given off by the arc lamp there must be some form of a condenser in connection with it. This can be a large condenser such as is used with magic lanterns (figs. 5, 6, 7, 8, 11, 13) or for the simplest apparatus it is a small condenser in a tube extending out in line with the upper carbon of the arc lamp (figs. 1-3, 12, 14-15). In all the lamps now used for drawing the special condenser is in a telescoping tube so that it can be put at its principal focal distance from the carbon tips, when it will give a beam of nearly parallel light, or the tube can be pulled out more or less, thus giving a converging cone of light.

For a microscope, any compound miscroscope can be used which can be inclined to the horizontal.

For reflecting the image forming rays down upon the drawing paper, a mirror or prism must be put at the end of the tube of the microscope whether an ocular is used or not (fig.1,-15).

The only difficulty one is liable to have with the microscope is that the fine adjustment may not work well when the microscope is made horizontal.

Suppose now that one has a complete outfit, how shall it be put in actual use?

Starting the Arc Lamp

(1) The carbons of the arc lamp should be separated so that they do not touch.

(2) The separable plug is screwed into any lamp socket near the point where the drawing is to be done.

(3) The key switch of the lamp socket is turned on.

(4) The cap of the separable plug connected with the wiring of the arc lamp is pushed in place.

(5) The carbons of the arc lamp are brought in contact by using the feeding screws of the lamp. If there is current there will be a flash of light. The carbons must be at once slightly separated and the arc will be fully established.

Stopping the Arc Lamp

For putting out the light there are three safe methods:

(1) The carbons are separated by turning the feeding screws of the arc lamp.

(2) If there is a special knife switch as shown in fig. 6, s., that can be opened.

(3) The cap of the separable plug can be pulled off.

Of course one can turn off the current by the use of the key switch in the socket used for turning on and off the incandescent light, but the sockets are not constructed for so much current as is used with the arc lamp, and there is danger of a short circuit and a burning out of the socket or a blowing out of the nearest fuse on the line. It is better, therefore, to shut off the current by either of the three safe methods. If one must turn off the current by the key switch of the lamp socket, it should be snapped over as quickly as possible.

Getting the Light Through the Microscope

There are two different arrangements of the lamp and the microscope (figs. 1-3, 12, 15 and figs. 5-9, 12-14).

(1) All the parts are put in one continuous line, then the source of light, the principal axis of the lamp condenser and of the substage condenser, the objective and the ocular, when one is used, form one continuous axis. This is theoretically the best possible arrangement and is entirely practicable when one has an optical bench on which to arrange the parts as in figs. 5-11, 13. Where there is no optical bench, there is much difficulty in lining up the microscope and the lamp.

(2) The microscope and the lamp with its condenser are placed on the same level, but at approximately right angles to each

other, and the microscope mirror is used to direct the light through the microscope as in ordinary microscopic observation. Where there is no optical bench as in figs. 1-3, 12, 14-15, it is much easier to get the light through the microscope with this arrangement than with the lamp and microscope in one axis.

For getting the light through the microscope when all parts are in line the microscope mirror is removed or turned aside and then one must adjust the lamp with its condenser until the light goes through the microscope. If there is no optical bench, this is easier said than done, especially with high powers.

With the lamp and microscope at right angles the light is got through the microscope in this simple mechanical fashion:

(A) A disc of card-board, asbestos or tin 15 cm. (6 in.) in diameter is blackened with some dull black paint like "dead-black Japalac;" a hole of the right size is made in the middle and it is put over the telescoping condenser tube as shown in figs. 1-3, 15. This shield helps to cut out stray light, but its main purpose is to act as a screen to aid in getting the light through the microscope.

(B) The plane mirror is set at about 45 degrees facing the lamp. When the light strikes the mirror it is reflected up to the microscope. The lower face of the substage condenser, or if no condenser is used, the slide bearing the specimen, reflects some of this light back on its path to the mirror, and the mirror reflects it back toward the lamp. This light will form a spot on the disc by the lamp condenser (fig. 4). If now one turns the mirror slightly so that the spot of light goes into the lamp condenser then the light will pass through the microscope, and if the reflector beyond the ocular (fig. 1 m^2) is present the image will appear on the drawing surface below, when the microscope is in focus. By a slight movement of the mirror the field will become evenly lighted.

USE OF THE SUBSTAGE CONDENSER IN DRAWING

For objectives of 16 mm. (2-3 in.) and higher the substage condenser can be used. It will insure the possibility of bringing into service the entire aperture of the objective. The diaphragm of the substage condenser should be wide open to start with. Sometimes it improves the reflected image to close it somewhat; but as a

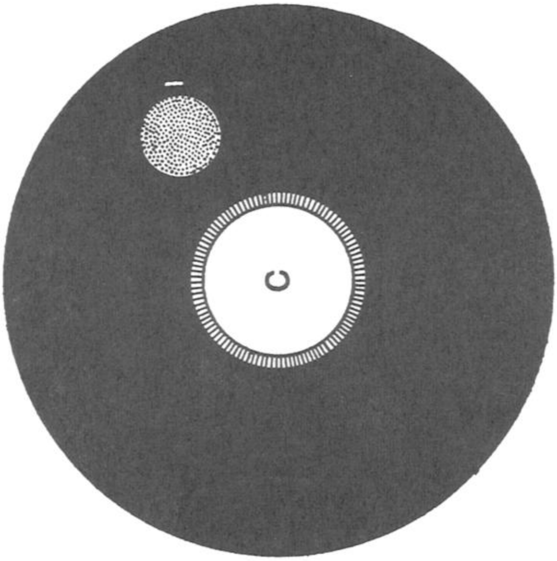

Fig. 4

Fig. 4. Black disc at the end of the lamp-condenser tube to cut off stray light and to receive the spot of light reflected back from the substage condenser.

C. The lamp condenser; I, the spot of light reflected back from the substage condenser.

rule it will be found that for drawing, the diaphragm is considerably wider open than for ordinary direct observation.

Mirror to Use.—If a mirror is used to direct the light as in fig. 1-3, then for the 16 mm. one should use the concave mirror and for objectives of 8 mm. and higher the plane mirror should be used.

For objectives lower than 16 mm. the substage should be removed or turned aside and the concave mirror used; or if the parts are all in line (fig. 5-14), the lamp condenser should be in posi-

tion to give a converging cone of light, and the lamp brought near enough the microscope to fully light the object.

In using the substage condenser for drawing with projection it is necessary to be more precise than for ordinary observation. One should be careful in the first place to have the lamp-condenser so that it gives a practically parallel beam of light as the usual substage condenser is constructed for parallel beams. In the second place the entire field should be lighted. For this one must vary the position of the substage condenser for different objectives. Its position for high powers must be changed depending on the thickness of the slide used also.

A slight change in the position of the substage condenser often acts like magic on the projected image.

Mirror or Prism for Reflecting the Image Forming Rays Downward to the Drawing Surface

If a prism is used it should be large enough to include the entire field, and it must be accurately set to reflect the axial beam so that it strikes the drawing surface at right angles. If a mirror is used, it must be silvered on the face or be of thin glass, otherwise there will be a troublesome double reflection. The mirror likewise should have a stop at the proper angle. For the horizontal microscope the mirror or prism reflects the rays downward at right angles. All that one has to look out for is to have the mirror or prism at 45 degrees and directly above the ocular. If it is at all sidewise there will be a lateral distortion of the image. This is easily seen by turning it considerably, when the projected field will be oval and not circular as it is when the mirror or prism is directly above the ocular.

Drawing in a Dark Room or in the Evening

For drawing in the evening or in a dark room all one needs is any one of the outfits shown and a screen or shield to prevent stray light from the arc lamp from falling on the drawing surface or getting into the face of the draughtsman. A vertical shield of black card-board is good (fig. 2), or a metal enclosure (fig. 14) or the cloth tent (figs. 12, 15).

For drawing in a light room there must be some kind of an enclosure to cut off the excess stray light. There are usually

plenty of rooms or shady corners where only a moderate amount of shading is necessary, then any of the devices shown in figs. 3, 12-15 will answer. But one must not forget that a screen image which looks brilliant in a dark room will look gray and washed out in a light place.

Objectives and Oculars to Use

So effective is the arc lamp on the house circuit that one can use objectives from the lowest to the water or oil immersions.

The lower oculars give more brilliant images than the higher ones just as for ordinary microscopic observation, but one can use even with the oil immersion, occulars as high as the x8 or x12.

Magnification of the Drawing

This is easily obtained by the use of a stage micrometer. The image of the spaces on the micrometer will, of course, be magnified just the same amount as the specimen drawn, and knowing the actual size of the spaces one can get the size of the image and divide the size of the image by the size of the object and the quotient will be the magnification. For example if the micrometer is in 100ths mm. and the image of one space measures 2.5 mm. then the magnification must have been 250 times linear.

For varying the magnification to get any desired size one has several resources:

(1) Use a higher or lower objective.

(2) Use a higher or lower ocular.

(3) For slight variations in magnification the easiest method is to put the drawing surface farther from or nearer the microscope. This can be accomplished by raising the microscope higher up from the table by the use of aditional blocks or the elevating devices provided (figs. 11, 15) or by the use of an adjustable drawing shelf (figs. 5-9, 13); or finally by the use of a separate drawing table and mirror which can be moved nearer to or farther from the microscope (fig. 8).

For Drawing Large Objects

The small outfits shown in figs. 1-3, 12, 14, 15, do not enable one to draw objects much over 5 mm. in diameter when an ocular is employed. If no ocular is used then objects 10 mm. in diame-

ter can be drawn. For larger objects, indeed extending up to lantern slide size, one must be supplied with a condenser such as is used for lantern slide projection. The special tube and condenser of the small arc lamp is removed and the lamp put into a lamp-house. Then by the use of a suitable stage or holder for the objects and a suitable objective one can draw objects from the size of lantern slides down, and at a magnification from x1 upward.

This is one of the best possible ways of getting lecture room diagrams. For that, one naturally uses a vertical drawing surface, and gets the size by the greater or less distance (see also figs. 11, 13).

For large microscopic objects no ocular is used, and in most cases no substage condenser. The converging cone of light from the large lamp condenser answers perfectly for the illumination. A person who has not tried it will be astonished at the results which can be obtained by means of the arc lamp on the house circuit for lantern slide projection as well as for making drawings.

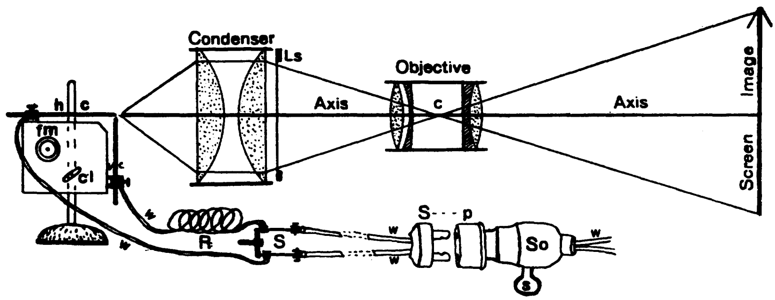

Fig. 6

Fig. 6. Diagram showing the wiring and the relation of the parts for lantern slide projection by means of the house electric lighting system.

The arc lamp and its wiring and connection with a rheostat and the house system is the same as in fig. 1, except that in this figure there is a knife switch (S) introduced to furnish means for turning on and off the current with absolute safety. Instead of a microscope there is present a projection objective for lantern slides (L S).

For projection and drawing with high powers when an ocular is used with one of the magic lantern condensers, figs. 9, 11, 13, one must use a special substage condenser or the converging cone of light from the larger condenser must be rendered parallel before

it reaches the ordinary substage condenser. For this a concave lens is put in the path of the converging beam at a point so that the parallel beam will be of the diameter of the substage condenser. The focus of the concave lens to use for parallelizing the rays depends upon the focus of the condenser. If it is about 15 cm. from the lens face to its focue then a concave lens of 16 to 20 diopters

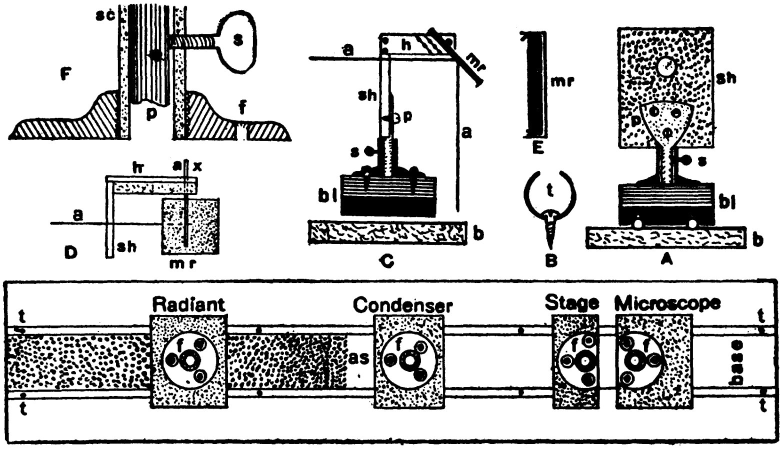

Fig. 10

Fig. 10. Diagrams to show how to construct an optical bench and the blocks with sockets for holding the different pieces of apparatus.

In the lower figure is shown a face view of the base board (base) with its tracks of brass rods (t-t), and with the blocks with their sockets for receiving the different pieces of apparatus. Each block is independent and slides freely back and forth on the track. Under the block carrying the arc lamp (Radiant) is a covering of asbestos (as).

A. End view of the base board and its tracks (b) with a block (bl) for carrying the objective. The block is partly of wood (the blackened portion) and has V-shaped grooves in it which rest on the tracks. The upper part of the block is of sheet lead to give weight and stability.

The post is a bolt flatteded at one end (p) to fasten to the wooden shield (sh) which carries the objective. The lower end of the bolt is received by the socket and fixed by the set screw at the side (s).

B. Sectional view of the track showing how it is fastened to the base board.

C. Side view of an apparatus block (bl) showing how the drawing mirror (mr) is supported from the shield (sh) holding the objective. The axial ray of the image forming beam is also shown (a-a).

D. View from above of the drawing mirror and its support.

E. Section of the mirror showing how the glass is held in a copper casing.

F. Sectional view of the socket for receiving the post of the apparatus. It is made of a railing flange with a short brass or iron tube for socket. The set screw (s) can be put at any desired level. This flange is screwed to the top of the supporting blocks as shown in the lower figure.

will answer. If the main condenser has a focus of 20 to 40 cm. (8-16 in.) then a concave lens of 8 to 12 diopters suffices. Indeed with a main condenser of 25 to 35 cm. (10 to 14 in.) one can get very good results with the ordinary substage condenser if no parallelizing lens at all is used, but the converging cone of light is directed into the substage condenser at a point where its diameter is that of the lower end of the substage condenser.

Use of the Small Drawing Outfits for Demonstration

In the evening or in a dark room these small outfits are admirable for demonstrations to small classes. For the purposes of demonstration it is better to remove or turn aside the reflecting mirror over the ocular, and then to use a screen of white cardboard. White paper is one of the best screens ever used. One can project images with the oil immersion with the screen one meter (3 to 4 feet) from the microscope, and thus make the image visible to classes of 10 to 20 standing or sitting near. For the oil immersion, of course the specimen would need to be very transparent. With the objectives of 8 mm. and lower powers, and oculars of x 3 or x 4 one can project brilliant screen images at a distance of 2 to 4 meters (6-12 feet) in a well darkened room.

Up to the present time three optical houses have brought out small lamps and arrangements for drawing by the light from the house circuit.

All have been tested fully by me personally, and all have been found effective. All work more satisfactorily in the evening or in a dark room or in a shaded corner. Below are given figures of these outfits, and in the explanations of the figures are brought out the special points of each.

The complete, small outfit of Leitz, exclusive of the microscope, costs 169 marks in Germany. If the duty must be paid, the cost is $68.00 in New York. (Fig. 12).

The Bausch & Lomb simple outfit costs $25.00 exclusive of the microscope. (Fig. 14).

The Apparatus of the Spencer Lens Company, exclusive of the microscope, costs $38.00. (Fig. 15).

With all, the various parts are sold separately, and any one interested could get the special circulars of the different houses with the prices of the separate parts.

If one already possesses some of the parts, and has a little ingenuity, a drawing outfit can be assembled in the laboratory or home which will answer all requirements at a considerable saving of expense, although it may lack some of the conveniences in the regularly made outfits.

If one works long at a time the rheostat gets pretty hot, and occasionally hot cinders fall from the burning carbons, hence it is wise to set the lamp and rheostat on a blackened sheet of asbestos.

Plate XIX

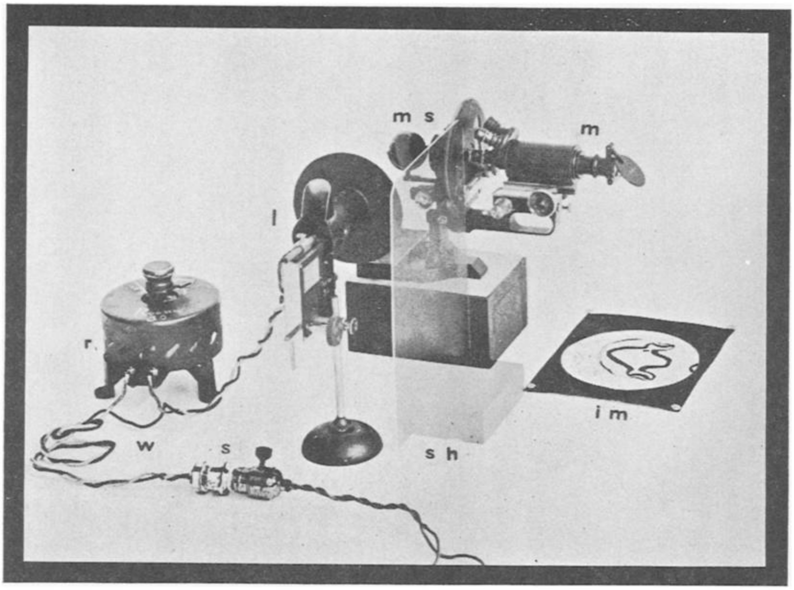

Fig. 2

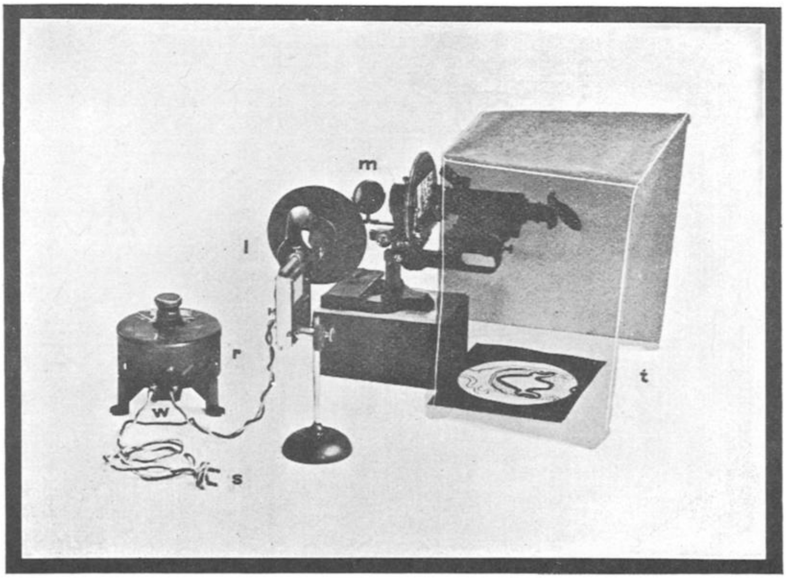

Fig. 3

EXPLANATION OF PLATES

Plate XIX

Fig. 2. Photograph of the author's drawing outfit, for the house lighting system, arranged for evening or dark room drawing.

s-w. Separable plug and wires connecting the house lighting system with the arc lamp.

r. Rheostat in series (i. e. in one wire). It does not allow more than 5 to 6 amperes of current to flow.

l. Arc lamp with small carbons at right angles. There is a black disc at the end of the lamp-condenser tube to aid in getting the light through the microscope. The lamp is at right angles to the microscope, but it can also be used in the optic axis if desired.

m-s. Microscope mirror and substage condenser.

m. Tube of the microscope and a 45 degree mirror or prism to reflect the image forming rays down upon the drawing surface.

im. Image on the drawing surface.

sh. Shield of blackened card-board to cut off stray light from the drawing surface and the face of the observer. It was left in place about three fourths of the time of exposure of the negative, hence it appears as if transparent.

Fig. 3. Photograph of the author's drawing outfit for the house lighting system with a black, cloth tent over the end of the microscope and the drawing surface, for use in a light room.

s-w. The cap of the separable plug and the two wires from the same to the arc lamp. One wire is cut and the two ends joined to the rheostat so that the current shall traverse the rheostat.

r. Rheostat in series; it does not allow more than five or six amperes of current to flow.

l. Arc lamp with condenser for giving parallel rays; it is at right angles with the miscroscope but may be used in the optic axis if desired; it is easier for many to get the light through the microscope with this relation than with the lamp in line with the microscope.

m. Mirror of the microscope.

t. Tent of black cloth supported by a wire frame. It cuts off stray light from the drawing surface, and enables one to draw in a light room.

Plate XX

Fig. 5. Photograph of the author's apparatus for drawing objects the size of lantern slides.

The illumination can be by the ordinary heavy lantern slide current, or by the small current of the house lighting supply. If the current is direct, then the automatic arc lamp of the Bausch & Lomb Optical Co. can be used for currents from 5 to 25 amperes. The 5 ampere current is sufficient for drawing. If one wishes to draw on a horizontal surface, then a mirror is put beyond the objective. If the drawing is on a vertical surface, as for wall diagrams, then the mirror is removed.

a-a-a, axis; as., adjustable shelf attached to the table legs; b., the base board with track (see fig. 10); c, triple condenser with water cell; l, automatic arc lamp; l-s, lantern slide carrier; m, mirror beyond the objective; o, objective; r, rheostat of the theater dimmer type; s., table switch for turning the current on and off the lamp; w., wire cable from the supply; tw., triple wire to the arc lamp.

Fig. 7. Photograph of the author's apparatus for drawing with the microscope without an ocular or substage condenser.

The arc lamp is Mr. Albert T. Thompson's automatic lamp for direct current. It can be used on small currents, and up to 25 amperes.

This is the first automatic arc lamp for right angled carbons.

By means of the optical bench carrying all the apparatus, the different parts are pulled forward so that the microscope tube and mirror project over the drawing shelf. This is adjustable up and down for varying the magnification.

The stage of the microscope (st) is independent and contains a large glass water cell against which the specimen rests. It conducts away the heat from the specimen.

Plate XX

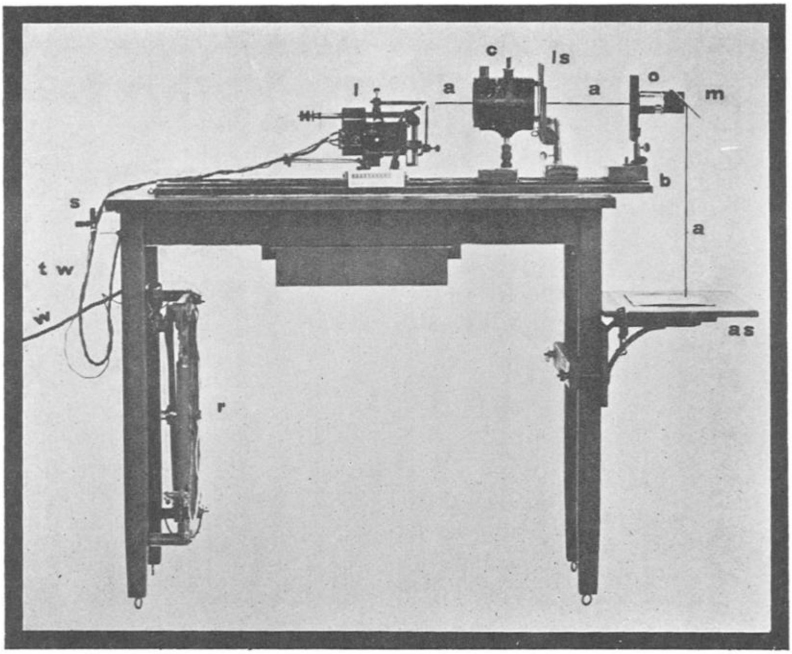

Fig. 5

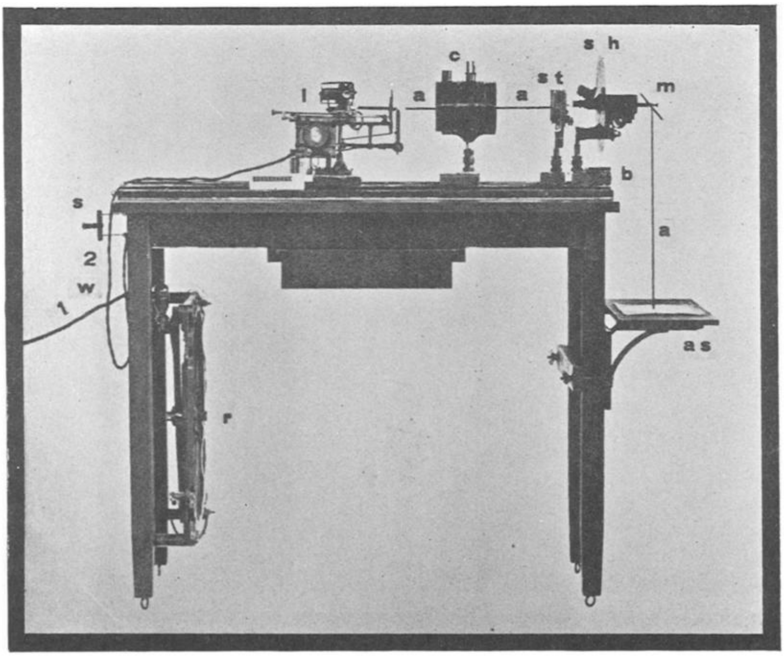

Fig. 7

Plate XXI

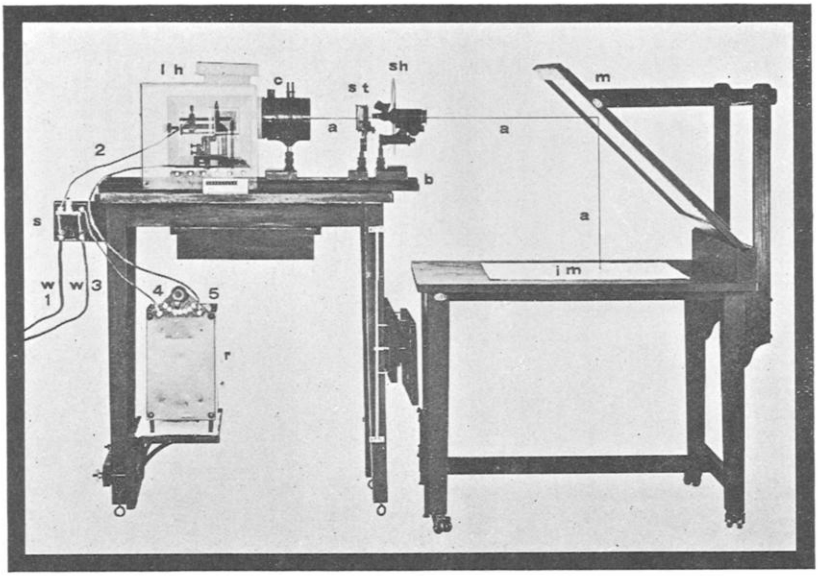

Fig. 8

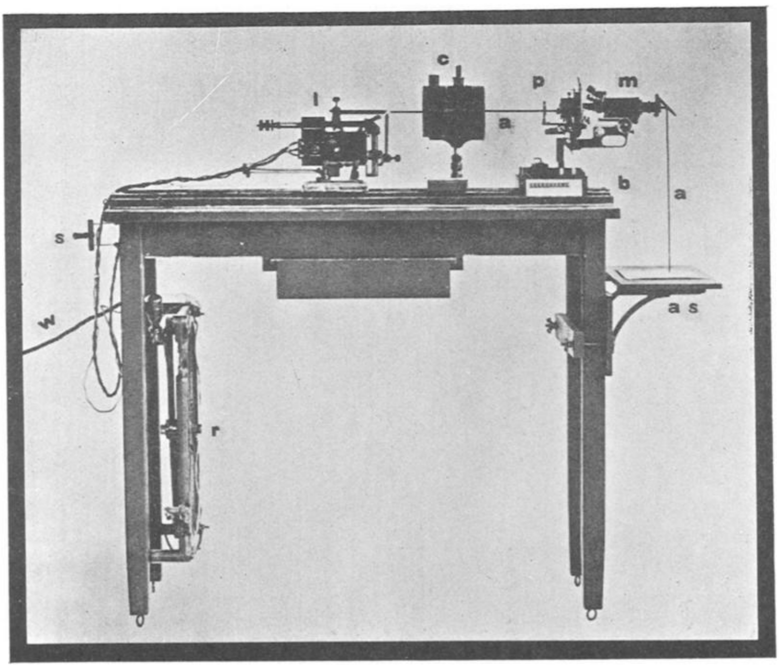

Fig. 9

Plate XXI

Fig. 8. Photograph of the author's apparatus for drawing with the microscope and a movable table with large plate glass mirror. a-a-a, Axial ray of the illuminating and image forming beam; b, base board of the optical bench; c, condenser with water cell; im, drawing surface where the image is projected; l h, lamp house. It was present only during a part of the exposure of the negative, hence it appears transparent, showing the hand-feed arc lamp within; m., the large mirror attached to the drawing table; r, rheostat. It is of the ordinary form; s, the double pole, table switch for opening and closing the circuit; w 1, 2, supply wire to the switch and from the switch directly to the arc lamp; w 3, 4, 5, (upper carbon) the supply wire to the switch, and from the switch to the one binding post of the rheostat (4); from the other binding post of the rheostat (5) a wire passes directly to the arc lamp (lower carbon). No current can go through the lamp without going through the rheostat with this arrangement; and with the double pole switch, the current is cut completely off the entire apparatus when the switch is open. The adjustable drawing shelf has an arrangement for moving up and down on metal ways which can be attached to any table, whatever the form of the legs. The supporting brackets are jointed so that the shelf can be let down when the large drawing table needs to be brought up close to the projection table. This method of moving the drawing shelf and lowering it is due to Dr. B. F. Kingsbury.

Fig. 9. Photograph of the author's apparatus for drawing with the large condenser, an ordinary microscope and an ocular.

Plate XXII

Fig. 11. Edinger vertical drawing and photographic apparatus for use on the house current. Made by E. Leitz.

The arc lamp is of the Liliput form with small right angled carbons.

The lamp condenser is large, such as is used for lantern slide projection, hence large as well as small objects can be illuminated by it.

For convenience in feeding the carbons there is a rod extending down within reach of the artist.

The microscope and stage are separate and independently movable on the vertical optical bench. In addition to the lamp condenser there are two or more substage condensers of different foci.

The object is put on the upper side of the stage.

The microscope can be used with an ocular, or the draw tube and ocular can be removed from the large microscope tube, and then objectives alone used, thus giving very large fields.

If desired for projection on a vertical screen, the apparatus rotates on a central axis to the horizontal position.

The vertical position is advantageous for drawing objects which must remain horizontal, but for most microscopic specimens which can be put in a vertical position, the apparatus is less convenient than one of the horizontal outfits.

Plate XXII

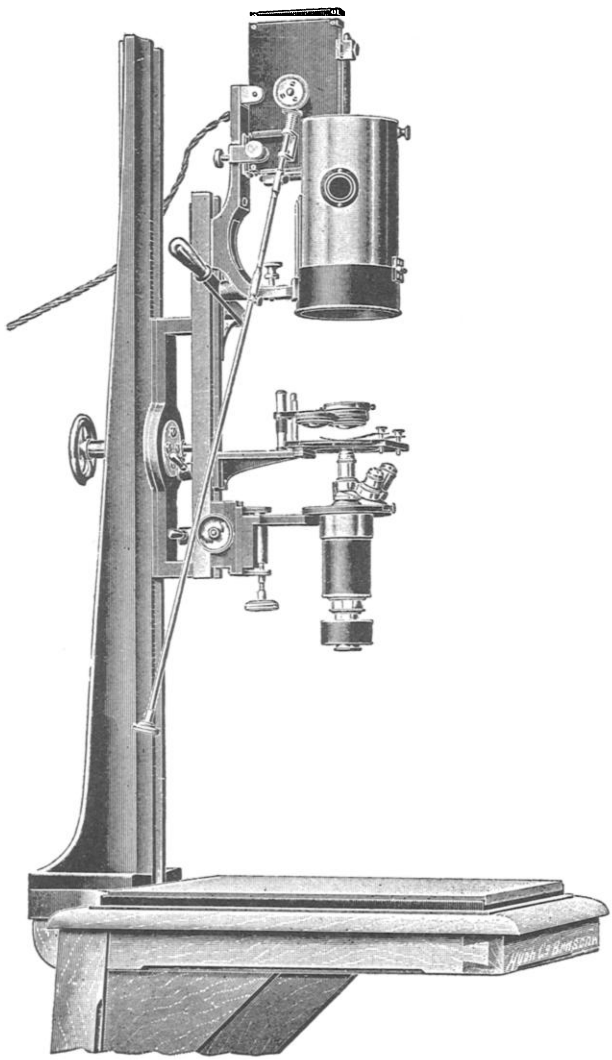

Fig. 11

Plate XXIII

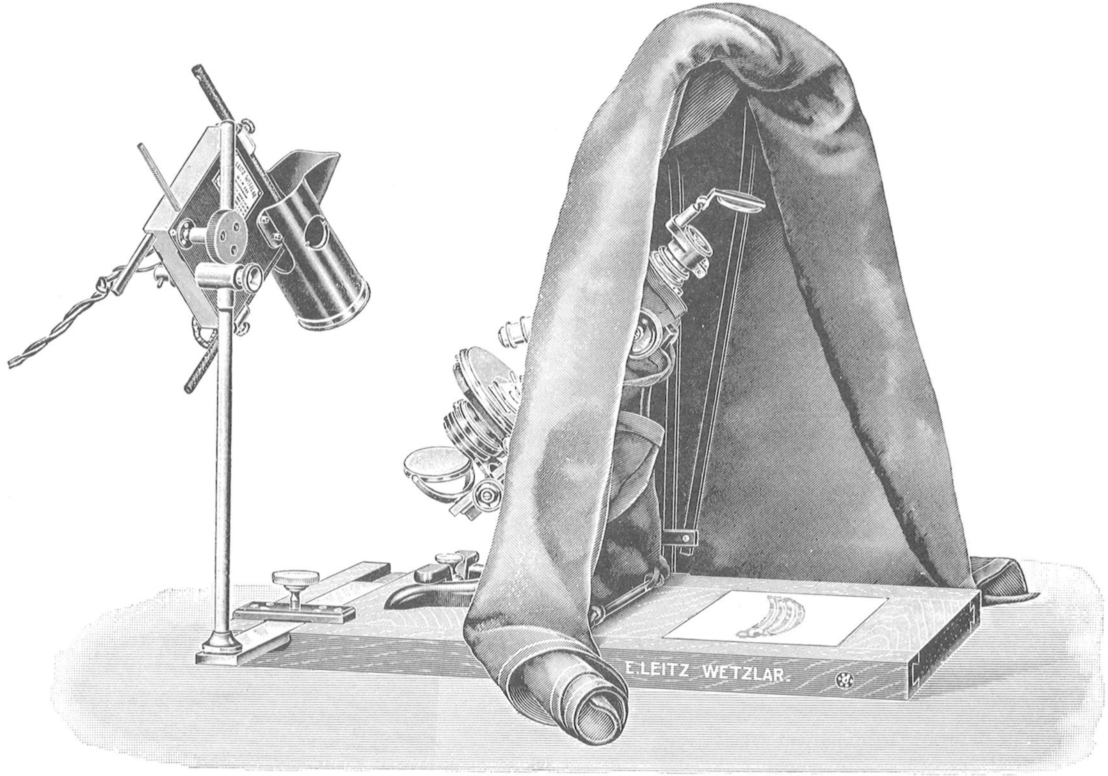

Fig. 12

Plate XXIII

Fig. 12. Edinger's drawing microscope with cloth tent. Made by E. Leitz, Wetzlar.

The lamp condenser is small, and composed of a single double convex lens at the end of a telescoping tube. If the tube is in, the beam is nearly parallel, if pulled out more or less there is a converging cone of light. The lamp is supported on a vertical tube and can be set at any desired height and at any angle. As shown, the mirror is used to direct the light up through the microscope.

The microscope itself is inclined at 45 degrees and the mirror at 22½ degrees, thus directing the light vertically down upon the drawing surface.

It is necessary to be careful in giving the microscope and the mirror the right inclination or the image will be distorted. The correct adjustment is more difficult than with the horizontal microscope.

For drawing in a light room a cloth tent is provided and is supported above and on the sides by metal arches. If it is very light one can pull the cloth over the head as in focusing a camera. In the evening or in a dark room the cloth can be opened widely to expose the drawing surface.

This apparatus was demonstrated at the meeting of the Anatomische Gesellschaft at its Leipzig meeting, April, 1911. With it one can draw with objectives of 50 mm. focus through the scale to oil immersions.

Plate XXIV

Fig. 13. Combined drawing and photomicrographic apparatus of the Bausch & Lomb Optical Company, for use on the house lighting system.

This is a kind of universal apparatus serving for drawing with the microscope, projection with a microscope and with a magic lantern; opaque projection, and finally for photographing with all objectives and with the microscope.

It can be used in a horizontal, an inclined or a vertical position. For drawing with the microscope in a horizontal position there is an adjustable drawing shelf with a cloth tent for shutting out daylight in a light room.

The large condenser enables one to use the apparatus on specimens of all sizes up to lantern slides.

Fig. 14. Simple drawing apparatus for the microscope, the Bausch & Lomb Optical Company.

There is a hand feed, right angled arc lamp for small carbons, wiring and connections for the house circuit and a rheostat which will not permit over 6 amperes of current to flow. The lamp condenser is in a telescoping tube so that either a parallel or a converging beam of light can be obtained.

The microscope is on a support giving a drawing distance of 25 centimeters (10 inches), and the drawing surface is enclosed by a metal shield to keep out stray light.

The lamp and the microscope are put in one line. For this the lamp is adjustable on a vertical support and it can be inclined at any angle.

If one finds it easier to use the mirror, and have the lamp at right angles to the microscope, this outfit lends itself perfectly to that arrangement.

Plate XXIV

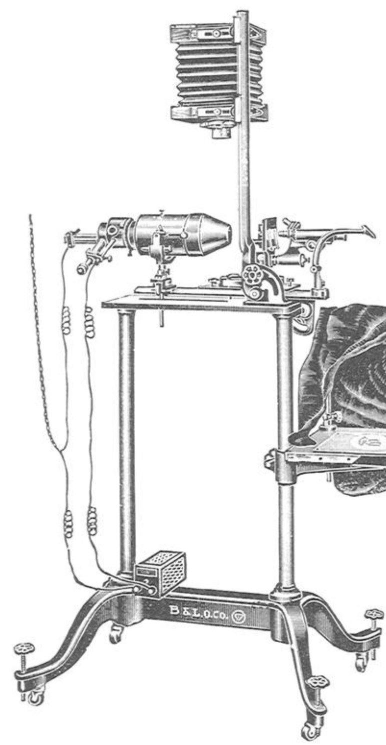

Fig. 13

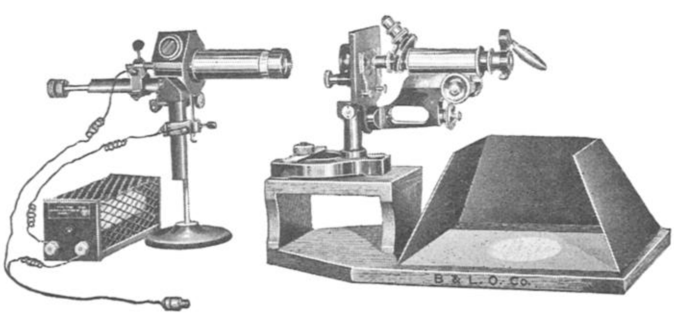

Fig. 14

Plate XXV

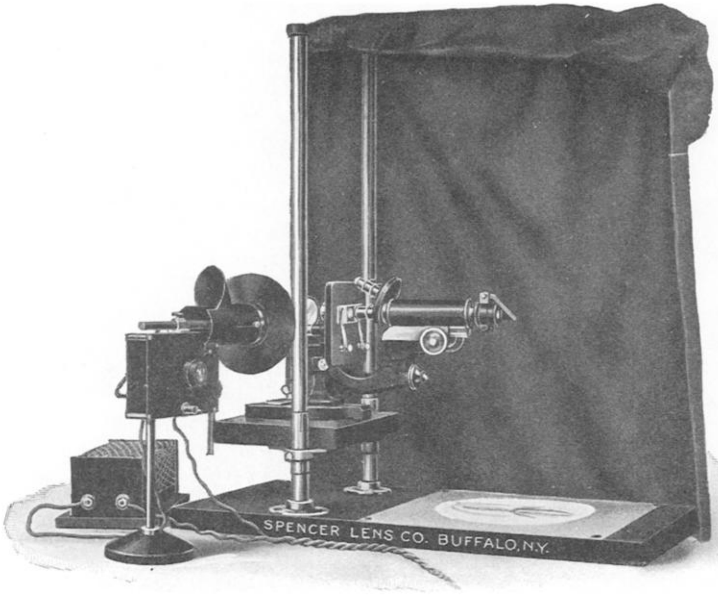

Fig. 15

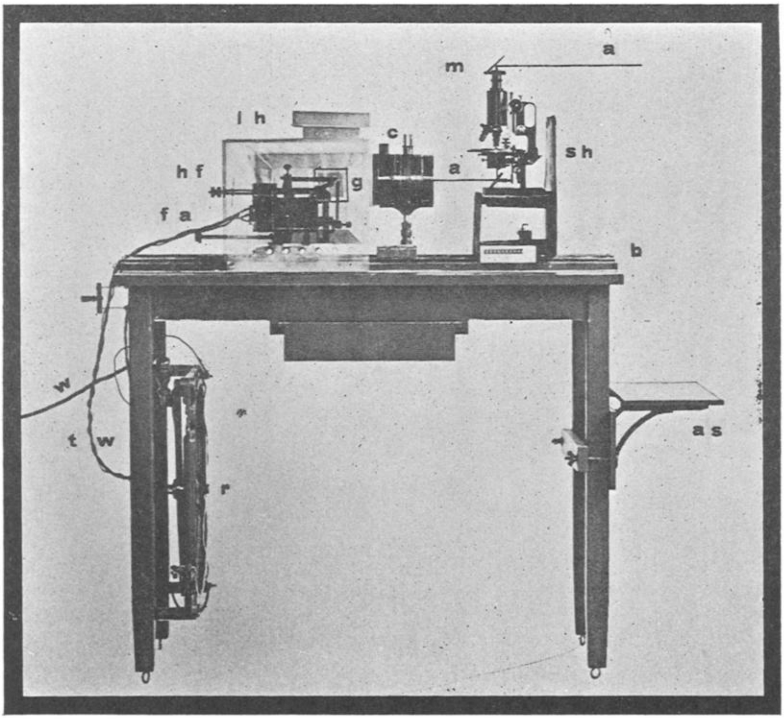

Fig. 16

Plate XXV

Fig. 15. Spencer Lens Company's apparatus for drawing with the microscope.

This consists of a small arc lamp with the proper wiring, rheostat and connections for the house electric supply. The lamp has all the adjustments, and the condenser tube is telescoping so that the beam of light may be parallel or converging.

At the end of the condenser tube is a black disc for cutting off stray light and serving as a screen upon which the spot of light from the substage condenser can be thrown, thus serving as an aid in getting the mirror at the right angle to send the light through the microscope.

The microscope is supported on an adjustable shelf which can be raised or lowered on the vertical rods, thus enabling one to get any desired magnification.

The vertical supports for the microscope shelf serve to carry a curved metal band to support the cloth curtains to shade the drawing surface. There are two curtains and they hang freely, thus avoiding all interference with the hands in drawing. If one desires, the arc lamp can be put in line with the microscope and the mirror turned aside.

For a reflector beyond the ocular a prism is used, thus avoiding any defects of a mirror.

Fig. 16. Photograph of the author's large projection outfit arranged for use with a vertical microscope.

This shows that the microscope mirror turns the illuminating beam from the condenser up through the microscope, and that to get the image on a vertical screen in the lecture room it is necessary to use a second mirror or prism to direct the beam horizontally again.

The lamp is the new three wire automatic lamp of the Bausch & Lomb Optical Company. The feeding screws (hf) and the fine adjustment screws (fa) project out behind the lamp house (lh). The lamp house was left in position about three fourths of the time of exposure of the negative, hence it appears transparent, showing the arc lamp within. The window for observing the arc is opposite the ends of the carbons (g).